

The opinion in support of the decision being entered today was **not** written for publication and is **not** binding precedent of the Board.

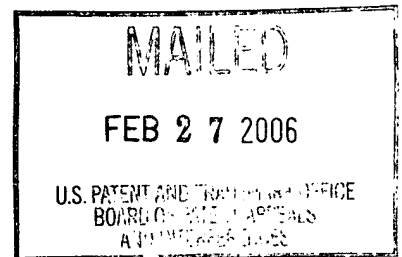
UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte TING CHIEN, CHRISTINE NELSON, and DOUGLAS KEIL

Appeal No. 2006-0291
Application No. 09/820,692

ON BRIEF



Before PAK, WALTZ, and JEFFREY T. SMITH, Administrative Patent Judges.

WALTZ, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on an appeal from the primary examiner's final rejection of claims 1 through 4, 7 through 12, and 14 through 27, which are all of the claims pending in this application. We have jurisdiction pursuant to 35 U.S.C. § 134.

According to appellants, the invention is directed to a method of etching a dielectric layer with selectivity to an underlying stop layer comprising supporting a semiconductor

substrate in a plasma etch chamber of a dual frequency capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, where an etchant gas comprising a hydrogen-free fluorocarbon gas and an oxygen-containing gas is supplied to the plasma etch chamber with the showerhead electrode to etch openings in the dielectric layer (Brief, pages 2-3). Representative independent claim 1 is reproduced below:

1. A method of etching a dielectric layer with selectivity to an underlying stop layer, comprising:

supporting a semiconductor substrate in a plasma etch chamber of a plasma etch reactor, wherein the plasma etch reactor is a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, the substrate including a dielectric layer over a stop layer;

supplying an etchant gas to the plasma etch chamber with the showerhead electrode; and

etching openings in the dielectric layer by energizing the etchant gas into a plasma state by capacitively coupling RF energy into the plasma etch chamber, the etchant gas comprising a hydrogen-free fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an oxygen-containing gas and optional carrier gas,

wherein the plasma etch reactor comprises a dual frequency capacitively coupled plasma reactor and RF energy is supplied at two different frequencies to either the bottom electrode or at different first and second frequencies to the showerhead electrode and bottom electrode, and

wherein the pressure in the plasma etch reactor is 50 to 100 mTorr and temperature of the substrate support is +20°C to +60°C.

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The examiner has relied on the following references as evidence of obviousness:

Tahara et al. (Tahara)	5,356,515	Oct. 18, 1994
Loewenstein	5,741,396	Apr. 21, 1998
Schmitt (filed Sep. 22, 1999)	6,228,438 B1	May 08, 2001
Liu et al. (Liu) (filed Mar. 10, 2000)	6,451,703 B1	Sep. 17, 2002
Demmin et al. (Demmin) (filed Dec. 31, 1997)	6,635,185 B2	Oct. 21, 2003

The claims on appeal stand rejected under 35 U.S.C. § 103(a) as unpatentable over Liu in view of Schmitt, as also evidenced by Demmin, Tahara, and Loewenstein (Answer, page 3). Based on the totality of the record, we *affirm* the rejection on appeal essentially for the reasons stated in the Answer, as well as those reasons set forth below.

OPINION

The examiner finds that Liu discloses a method of etching a dielectric layer with selectivity to an underlying stop layer where the semiconductor substrate is supported in a plasma etch reactor, with an etchant gas of a hydrogen-free fluorocarbon being supplied to the plasma etch chamber through a showerhead at

pressures between 25 millitorr (mT) and 70 mT (Answer, pages 3-4). The examiner further finds that Liu teaches use of a capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode (a magnetically enhanced reactive ion etch (MERIE) plasma reactor) (*id.*). The examiner finds that Liu differs from the claimed invention by not specifying a "dual frequency" capacitively coupled plasma reactor (Answer, page 4). Therefore, the examiner applies Schmitt as evidence that a dual frequency capacitively coupled plasma reactor, including an upper showerhead electrode and a bottom electrode, was well known in the art (*id.*). From these findings, the examiner concludes that it would have been obvious to one of ordinary skill in this art at the time of appellants' invention to incorporate the well known plasma reactor of Schmitt in the process of Liu "in order to separately control the upper electrode and lower (bottom) electrode" (*id.*).

Appellants argue that Liu does not disclose a "showerhead electrode" but only a quartz gas distribution plate (Brief, page 6, footnote 1; page 7, footnote 2; Reply Brief, pages 2-3). Appellants further argue that the use of a MERIE reactor is an essential component of the Liu process (Reply Brief, pages 3-4). Appellants also argue that Schmitt is not related to etching

dielectric oxides as done by Liu and appellants, and thus there is no motivation for incorporating the dual frequency showerhead electrode of Schmitt in the MERIE plasma reactor of Liu (Brief, page 8; Reply Brief, page 6). Appellants argue that replacement of the quartz gas distribution plate of Liu with the showerhead electrode of Schmitt goes against the teachings of Liu and changes the operation of Liu (Brief, pages 9 and 11).

Appellants' arguments are not persuasive. Although the examiner does incorrectly categorize the showerhead of Liu as "a showerhead electrode" (Answer, page 6; see Liu, col. 4, ll. 34-45), this error is harmless. Contrary to appellants' arguments, the examiner is *not* modifying the Liu process by replacing the quartz gas distribution plate 70 with the showerhead electrode 3 of Schmitt. See the Answer, pages 4 and 6. We determine that the use of a MERIE plasma reactor is *not* an essential component of the Liu process. We also determine that Schmitt is directed to etching various materials. Finally, we determine that the examiner is not proposing that the quartz gas distribution plate of Liu be replaced by the showerhead electrode of the reactor of Schmitt (Answer, pages 4 and 6). Our reasoning follows.

Liu discloses that prior etching processes have been developed on the IPS Etch Reactor, which is a high density plasma

reactor (col. 3, ll. 50-57). Liu teaches that a desire exists for performing oxide etching in more conventional capacitively coupled plasma etch reactors producing a lower plasma density, of which the MERIE reactor is an example (col. 3, l. 62-col. 4, l. 7; col. 6, ll. 9-17). It is well settled that a reference is not limited to its examples. See *In re Widmer*, 353 F.2d 752, 757, 147 USPQ 518, 523 (CCPA 1965). Accordingly, we determine that Liu is not limited to a MERIE reactor, nor is this reactor an "essential" part of the Liu invention. As correctly found by the examiner, Schmitt is directed to the use of a dual frequency capacitively coupled plasma reactor useful for etching "various materials" (Answer, page 6, citing Schmitt, col. 1, ll. 1-40). From these findings, we determine that it would have been obvious to one of ordinary skill in this art at the time of appellants' invention to use well known capacitively coupled etch plasma reactors, such as the dual frequency capacitively coupled plasma reactor of Schmitt, to form the plasma in the process of Liu. This conclusion is further supported since Liu exemplifies a processing region **72** with "a showerhead having a large number of distributed apertures **76** so as to inject a more uniform flow of processing gas into the processing region **72**" while Schmitt teaches that his capacitively coupled RF plasma reactor is

improved to "notably reduce the electromagnetic non uniformity during the plasma process" (Liu, col. 4, ll. 42-45; Schmitt, col. 4, ll. 1-4).

Appellants argue that Liu "teaches away" from the claimed pressure and temperature of independent claims 1, 24 and 25 (Brief, page 12; Reply Brief, page 10). This argument is not well taken for several reasons. As correctly noted by the examiner (Answer, page 8), the teaching of a preferred pressure of "no more than 40 milliTorr" in Liu is directed to only one specific embodiment (col. 11, ll. 36-54), while the use of a low temperature is only found in the examples (Tables 1-4). Liu tests a range of pressures (25 to 70 mT) (col. 11, ll. 39-42) and further teaches various result-effective parameters, including the amount of oxygen and argon in the etching gas (col. 10, ll. 22-29), the residence time (col. 11, ll. 1-2), the magnetic field (col. 11, ll. 13-15), and the pressure and flow rates (col. 8, ll. 27-38). Further evidence of various result-effective variables in this art has been cited by the examiner (Answer, page 5). We also note that the optimal pressures taught by Liu are for a MERIE plasma reactor, not the dual frequency capacitively coupled plasma reactor of Schmitt. Accordingly, absent a showing of unexpected results, we determine that the

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pressure and temperature limitations as claimed would have been well within the optimization skills of one of ordinary skill in this art. See *In re Antonie*, 559 F.2d 618, 620, 195 USPQ 6, 8-9 (CCPA 1977).

With regard to appellants' arguments concerning various dependent claims (Brief, pages 14-18; Reply Brief, pages 12-16), we adopt the findings and conclusions of the examiner (Answer, pages 4-6), and rely as well on our comments above regarding result-effective variables. For instance, appellants argue that the flow rates recited in claim 8 on appeal are not disclosed or suggested by Liu in view of Schmitt (Brief, pages 15-16). However, not only does Liu teach overlapping ranges of flow rates for each claimed component (see Table 4 and col. 10, ll. 27-29), but Liu teaches that optimizing an "etching recipe" would have been well within the ordinary skill in this art (col. 11, ll. 55-64).

For the foregoing reasons and those stated in the Answer, we determine that the examiner has established a prima facie case of obviousness in view of the reference evidence. Based on the totality of the record, including due consideration of appellants' arguments and evidence, we determine that the preponderance of evidence weighs most heavily in favor of

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obviousness within the meaning of section 103(a). Accordingly, we affirm the rejection on appeal.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a)(1)(iv)(2004).

AFFIRMED


CHUNG K. PAK
Administrative Patent Judge

Thomas A. Waltz
THOMAS A. WALTZ
Administrative Patent Judge

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